

FIG.1

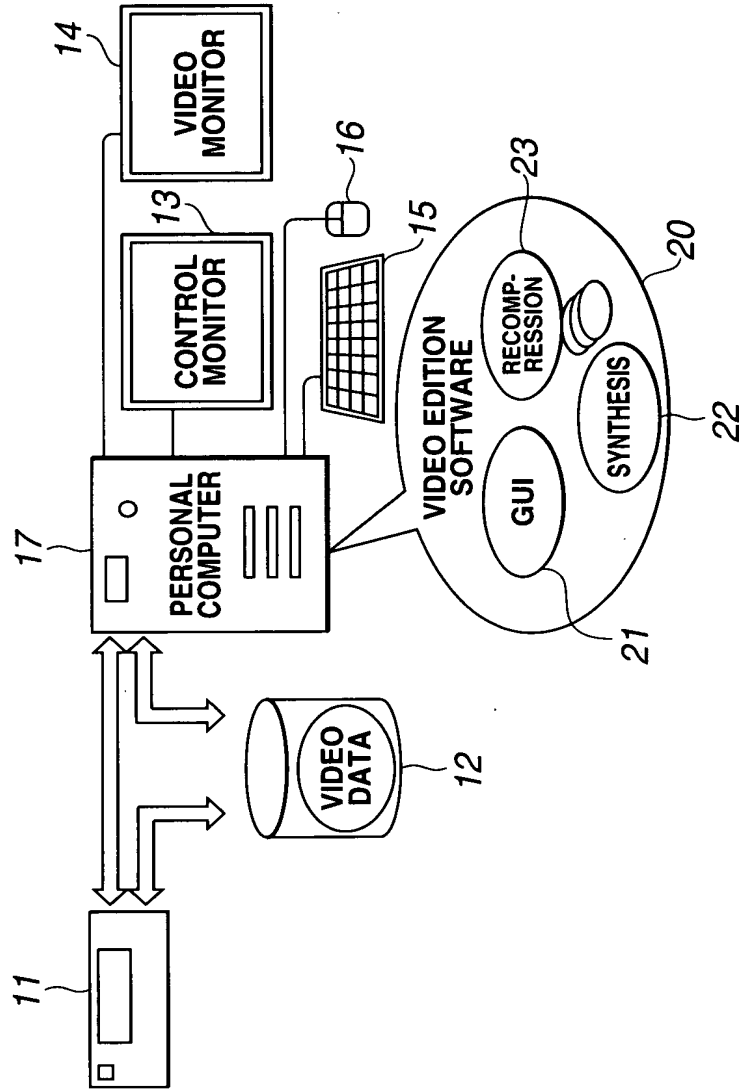
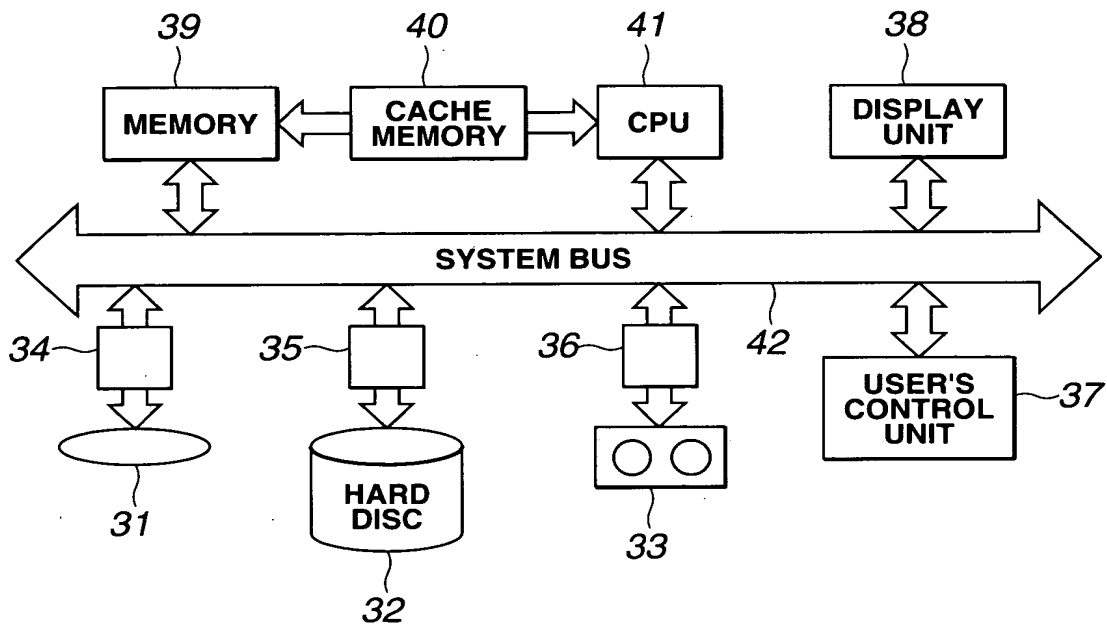


FIG.2

**FIG.3**

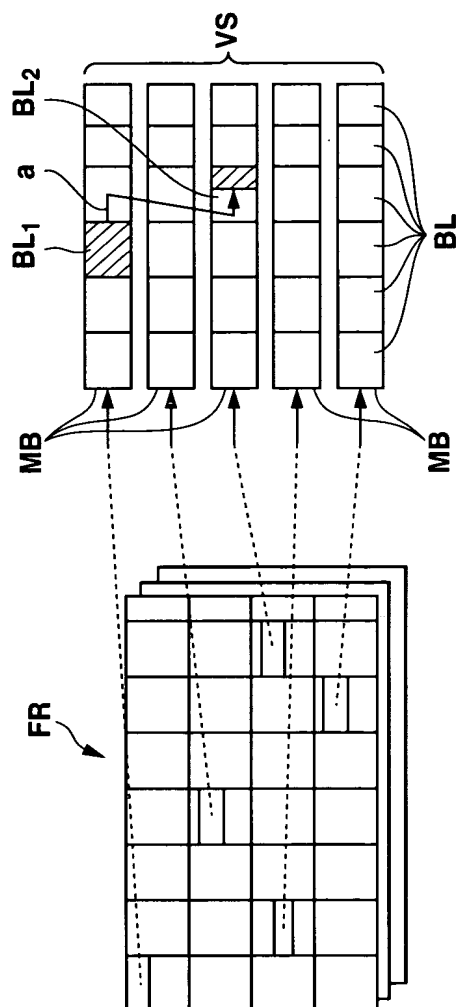


FIG.4

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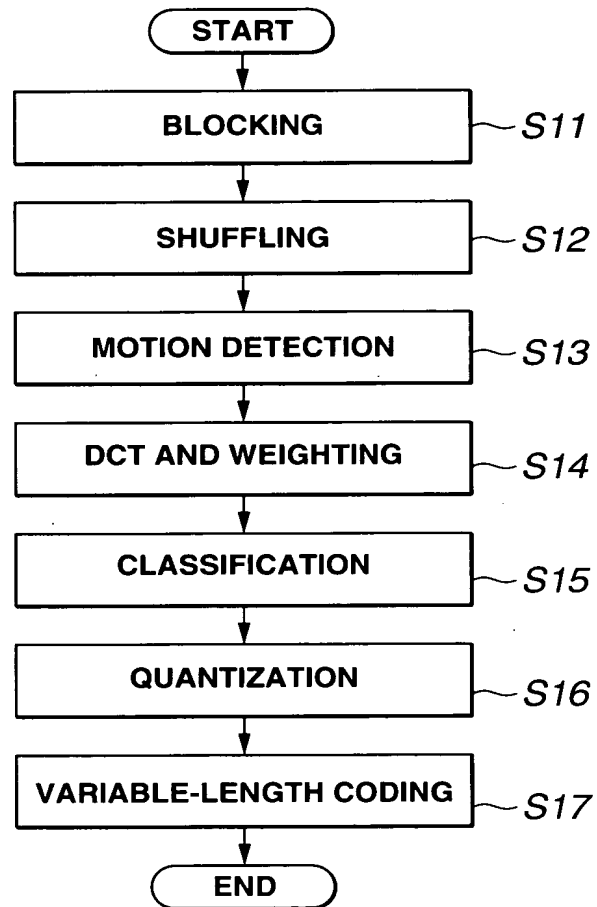


FIG.5

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| | CLASS NO.(CNO) | | | | AREA NO.(ANO) | | | |
|-----------------------|----------------|----|----|----|---------------|---|----|----|
| | 0 | 1 | 2 | 3 | 0 | 1 | 2 | 3 |
| QUANTIZER NO.(QNO) | 15 | | | | 1 | 1 | 1 | 1 |
| | 14 | | | | 1 | 1 | 1 | 1 |
| | 13 | | | | 1 | 1 | 1 | 1 |
| | 12 | 15 | | | 1 | 1 | 1 | 1 |
| | 11 | 14 | | | 1 | 1 | 1 | 1 |
| | 10 | 13 | | 15 | 1 | 1 | 1 | 1 |
| | 9 | 12 | 15 | 14 | 1 | 1 | 1 | 1 |
| | 8 | 11 | 14 | 13 | 1 | 1 | 1 | 2 |
| | 7 | 10 | 13 | 12 | 1 | 1 | 2 | 2 |
| | 6 | 9 | 12 | 11 | 1 | 1 | 2 | 2 |
| | 5 | 8 | 11 | 10 | 1 | 2 | 2 | 4 |
| | 4 | 7 | 10 | 9 | 1 | 2 | 2 | 4 |
| | 3 | 6 | 9 | 8 | 2 | 2 | 4 | 4 |
| | 2 | 5 | 8 | 7 | 2 | 2 | 4 | 4 |
| | 1 | 4 | 7 | 6 | 2 | 4 | 4 | 8 |
| | 0 | 3 | 6 | 5 | 2 | 4 | 4 | 8 |
| | | 2 | 5 | 4 | 4 | 4 | 8 | 8 |
| | | 1 | 4 | 3 | 4 | 4 | 8 | 8 |
| | | 0 | 3 | 2 | 4 | 8 | 8 | 16 |
| | | | 2 | 1 | 4 | 8 | 8 | 16 |
| | | | 1 | 0 | 8 | 8 | 16 | 16 |
| | | | 0 | | 8 | 8 | 16 | 16 |

FIG.6

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HORIZONTAL
→

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|----|---|---|---|---|---|---|---|
| 0 | DC | 0 | 0 | 1 | 1 | 1 | 2 | 2 |
| 1 | 0 | 0 | 1 | 1 | 1 | 2 | 2 | 2 |
| 2 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| 3 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| 4 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| 5 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| 6 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| 7 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |

VERTICAL ↓

FIG.7A

HORIZONTAL
→

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|----|---|---|---|---|---|---|---|
| 0 | DC | 0 | 1 | 1 | 1 | 2 | 2 | 3 |
| 1 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| 2 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| 4 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 3 |
| 5 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| 6 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| 7 | 1 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |

(SUM)
VERTICAL ↓
(DIFFERENCE)

FIG.7B

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HORIZONTAL
→

0 1 2 3 4 5 6 7

VERTICAL
↓

| | | | | | | | | |
|---|----|----|----|----|----|----|----|----|
| 0 | 1 | 2 | 6 | 7 | 15 | 16 | 28 | 29 |
| 1 | 3 | 5 | 8 | 14 | 17 | 27 | 30 | 43 |
| 2 | 4 | 9 | 13 | 18 | 26 | 31 | 42 | 44 |
| 3 | 10 | 12 | 19 | 25 | 32 | 41 | 45 | 54 |
| 4 | 11 | 20 | 24 | 33 | 40 | 46 | 53 | 55 |
| 5 | 21 | 23 | 34 | 39 | 47 | 52 | 56 | 61 |
| 6 | 22 | 35 | 38 | 48 | 51 | 57 | 60 | 62 |
| 7 | 36 | 37 | 49 | 50 | 58 | 59 | 63 | 64 |

FIG.8A

HORIZONTAL
→

0 1 2 3 4 5 6 7

(SUM)
↓
VERTICAL
(DIFFERENCE)

| | | | | | | | | |
|---|----|----|----|----|----|----|----|----|
| 0 | 1 | 3 | 7 | 19 | 21 | 35 | 37 | 51 |
| 1 | 5 | 9 | 17 | 23 | 33 | 39 | 49 | 53 |
| 2 | 11 | 15 | 25 | 31 | 41 | 47 | 55 | 61 |
| 3 | 13 | 27 | 29 | 43 | 45 | 57 | 59 | 63 |
| 4 | 2 | 4 | 8 | 20 | 22 | 36 | 38 | 52 |
| 5 | 6 | 10 | 18 | 24 | 34 | 40 | 50 | 54 |
| 6 | 12 | 16 | 26 | 32 | 42 | 48 | 56 | 62 |
| 7 | 14 | 28 | 30 | 44 | 46 | 58 | 60 | 64 |

FIG.8B

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| (run, amp) | | CODE | LENGTH | (run, amp) | | CODE | LENGTH |
|------------|----|-----------|--------|------------|----|--------------|--------|
| 0 | 1 | 00s | 2+1 | 11 | 1 | 111100000s | 9+1 |
| 0 | 2 | 010s | 3+1 | 12 | 1 | 111100001s | |
| EOB | | 0110 | 4 | 13 | 1 | 111100010s | |
| 1 | 1 | 0111s | 4+1 | 14 | 1 | 111100011s | |
| 0 | 3 | 1000s | | 5 | 2 | 111100100s | |
| 0 | 4 | 1001s | | 6 | 2 | 111100101s | |
| 2 | 1 | 10100s | 5+1 | 3 | 3 | 111100110s | |
| 1 | 2 | 10101s | | 4 | 3 | 111100111s | |
| 0 | 5 | 10110s | | 2 | 4 | 111101000s | |
| 0 | 6 | 10111s | | 2 | 5 | 111101001s | |
| 3 | 1 | 110000s | 6+1 | 1 | 8 | 111101010s | |
| 4 | 1 | 110001s | | 0 | 18 | 111101011s | |
| 0 | 7 | 110010s | | 0 | 19 | 111101100s | |
| 0 | 8 | 110011s | | 0 | 20 | 111101101s | |
| 5 | 1 | 1101000s | 7+1 | 0 | 21 | 111101110s | |
| 6 | 1 | 1101001s | | 0 | 22 | 111101111s | |
| 2 | 2 | 1101010s | | 5 | 3 | 1111100000s | 10+1 |
| 1 | 3 | 1101011s | | 3 | 4 | 1111100001s | |
| 1 | 4 | 1101100s | | 3 | 5 | 1111100010s | |
| 0 | 9 | 1101101s | | 2 | 6 | 1111100011s | |
| 0 | 10 | 1101110s | | 1 | 9 | 1111100100s | |
| 0 | 11 | 1101111s | | 1 | 10 | 1111100101s | |
| 7 | 1 | 11100000s | 8+1 | 1 | 11 | 1111100110s | 11 |
| 8 | 1 | 11100001s | | 0 | 0 | 11111001110s | |
| 9 | 1 | 11100010s | | 1 | 0 | 11111001111s | |
| 10 | 1 | 11100011s | | 6 | 3 | 11111010000s | 11+1 |
| 3 | 2 | 11100100s | | 4 | 4 | 11111010001s | |
| 4 | 2 | 11100101s | | 3 | 6 | 11111010010s | |
| 2 | 3 | 11100110s | | 1 | 12 | 11111010011s | |
| 1 | 5 | 11100111s | | 1 | 13 | 11111010100s | |
| 1 | 6 | 11101000s | | 1 | 14 | 11111010101s | |
| 1 | 7 | 11101001s | | 2 | 0 | 111110101100 | 12 |
| 0 | 12 | 11101010s | | 3 | 0 | 111110101101 | |
| 0 | 13 | 11101011s | | 4 | 0 | 111110101110 | |
| 0 | 14 | 11101100s | | 5 | 0 | 111110101111 | |
| 0 | 15 | 11101101s | | | | | |
| 0 | 16 | 11101110s | | | | | |
| 0 | 17 | 11101111s | | | | | |

FIG.9

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| (run, amp) | | CODE | | LENGTH | |
|------------|-----|------------------|--------------------------------------------|--------|--|
| 7 | 2 | 111110110000s | | 12+1 | |
| 8 | 2 | 111110110001s | | | |
| 9 | 2 | 111110110010s | | | |
| 10 | 2 | 111110110011s | | | |
| 7 | 3 | 111110110100s | | | |
| 8 | 3 | 111110110101s | | | |
| 4 | 5 | 111110110110s | | | |
| 3 | 7 | 111110110111s | | | |
| 2 | 7 | 111110111000s | | | |
| 2 | 8 | 111110111001s | | | |
| 2 | 9 | 111110111010s | | | |
| 2 | 10 | 111110111011s | | | |
| 2 | 11 | 111110111100s | | | |
| 1 | 15 | 111110111101s | | | |
| 1 | 16 | 111110111110s | | | |
| 1 | 17 | 111110111111s | | | |
| 6 | 0 | 1111110000110 | | 13 | |
| 7 | 0 | 1111110000111 | | | |
| ⋮ | ⋮ | 1111110 | BINARY NOTATION OF R: R=6 TO 61 | | |
| R | 0 | | | | |
| ⋮ | ⋮ | | | | |
| 61 | 0 | 1111110111101 | | 15+1 | |
| 0 | 23 | 111111100010111s | | | |
| 0 | 24 | 111111111111000s | | | |
| ⋮ | ⋮ | 1111111 | BINARY NOTATION OF A: A=23 TO 255 | | |
| 0 | A | | | | |
| ⋮ | ⋮ | | | | |
| 0 | 255 | 111111111111111s | | | |

FIG.10

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[illegible]

FIG. 11

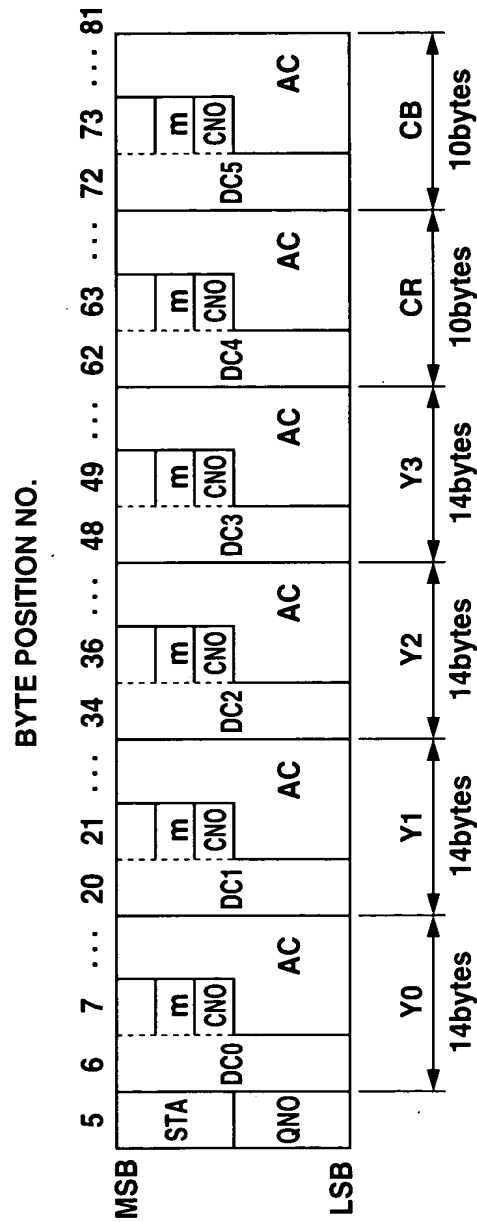
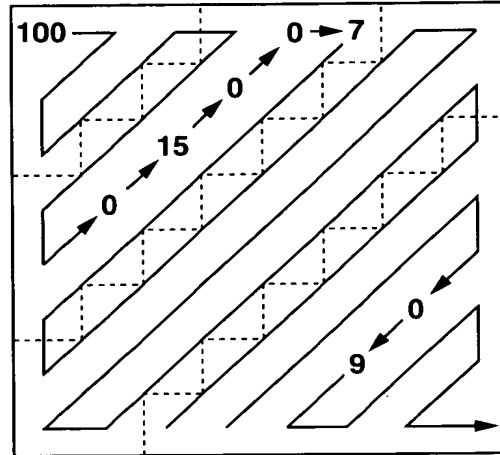
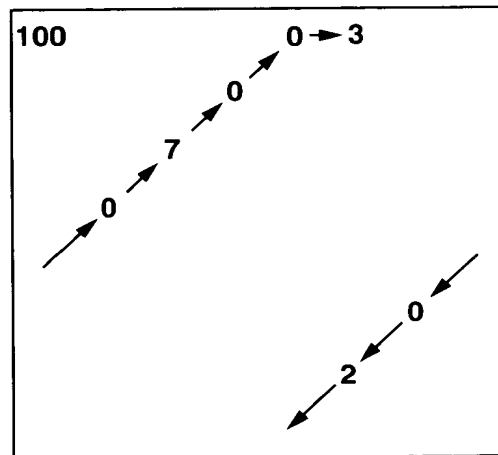


FIG.12

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**FIG.13A****FIG.13B**

... 0, 15, 0, 0, 7, 0, 9, ...

FIG. 14A

11111011111010, 11111011110001, ... 11111001000

13 13 11

FIG. 14B

... 0, 7, 0, 0, 3, 0, 2, ...

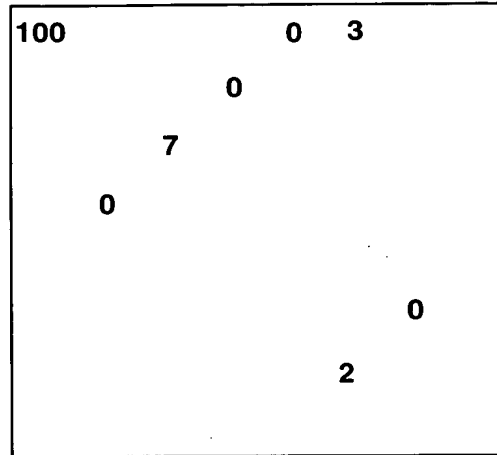
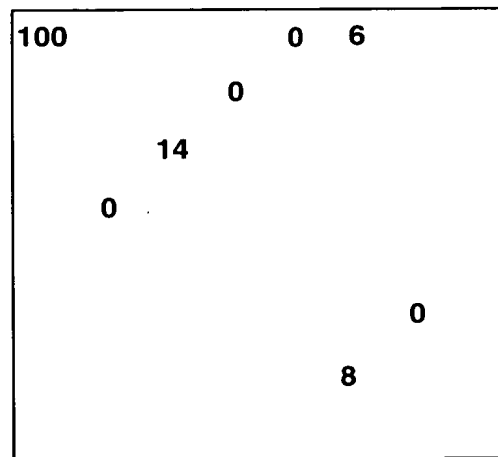
FIG. 14C

111010010, 111001100, ... 101010

9 9 6

FIG. 14D

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**FIG.15A****FIG.15B**

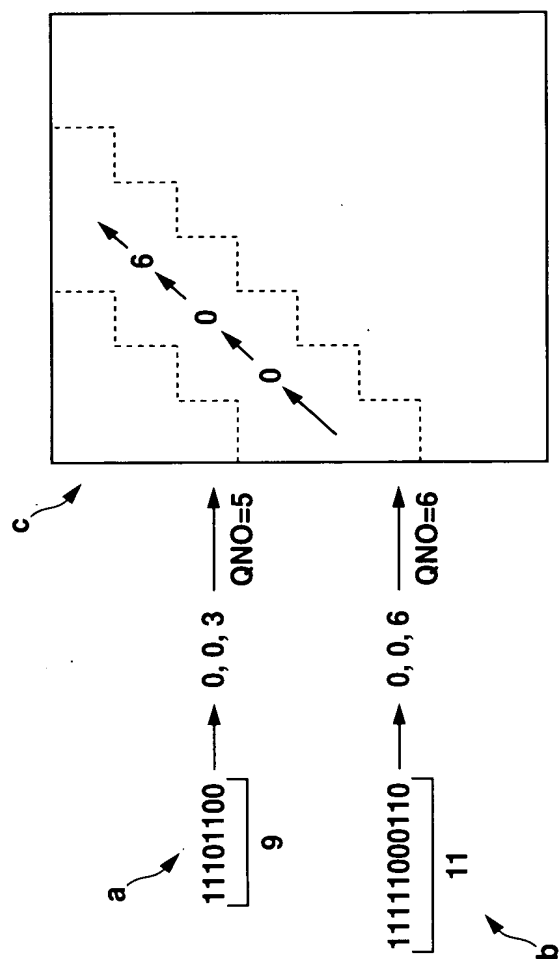


FIG.16

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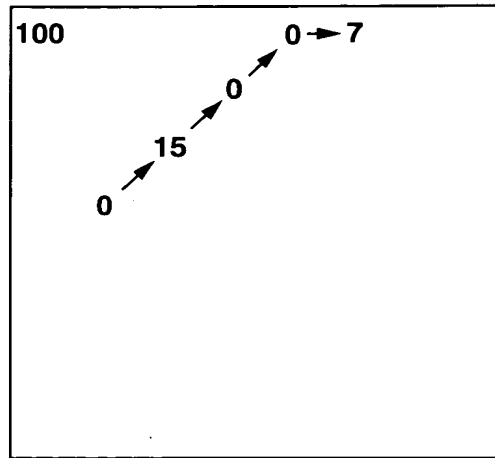
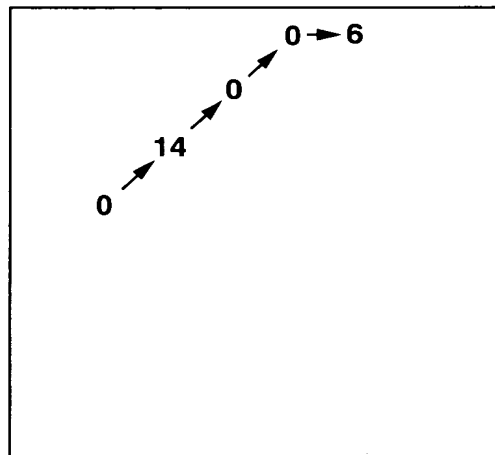
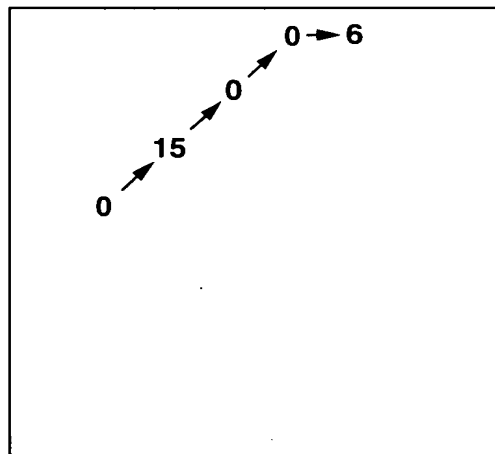
**FIG.17A****FIG.17B****FIG.17C**

FIG.18A QNO=6 → 1111101111010, 0, 15 (1, 15)
 1111101110001, 0, 17 (2, 7)

FIG.18B QNO=5 → 111010010, 0, 7 (1, 7)
 111001100, 0, 0, 3 (2, 3)

FIG.18C QNO=6 → 1111101111010, 0, 15 (1, 15)
 11111000110, 0, 0, 6 (2, 6)

```

static int sHuffmanReducible(int nAmp, int nRun)
{
    if(nAmp<0)
        nAmp=-nAmp;
    if(((nAmp<3)||((nAmp>23)))
        return 0;
    int nThisLength=sHuffmanLength(nAmp, nRun);
    int nNewLength=sHuffmanLength(nAmp-1, nRun);
    int nReduced=nThisLength-nNewLength;
    return(nReduced>0)?nReduced; 0;
}
static int sHuffmanReducibleToAmp0(int nAmp, int nRun, int nNextAmp, int nNextRun)
{
    int nThisLength=sHuffmanLength(nAmp, nRun);
    if(nNextRun==EOB){/*the end of data*/
        return nThisLength;
    }
    int nNextLength=sHuffmanLength(nNextAmp, nNextRun);
    int nNewLength=sHuffmanLength(nNextAmp, nRun+1+nNextRun);
    return nThisLength+nNextLength-nNewLength;
}

```

FIG.19

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```

static BOOL sQStepReductionTable0[4][16] = {
    {0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
    {0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0},
    {0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0},
    {0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0}
};
static BOOL sQStepReductionTable1[4][16] = {
    {0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0},
    {0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0},
    {0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0},
    {0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0}
};
static BOOL sQStepReductionTable2[4][16] = {
    {0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0},
    {0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0},
    {0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0},
    {0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0}
};
static BOOL sQStepReductionTable3[4][16] = {
    {0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0},
    {0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0},
    {0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1},
    {0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 0}
};

static BOOL sQStepReducible(int nQno, int nClassNo, int nAreaNo)
{
    switch (nAreaNo) {
        case (3) :
            return sQStepReductionTable3[nClassNo][nQno];
        case (2) :
            return sQStepReductionTable2[nClassNo][nQno];
        case (1) :
            return sQStepReductionTable1[nClassNo][nQno];
        case (0) :
            return sQStepReductionTable0[nClassNo][nQno];
        default :
            return FALSE ;
    }
}

```

FIG.20

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#define EOB 62

```
int RequantizeRunAmp(short* pRuns, short* pAmps, int nReducingSize, int nQno, int nClassNo)
{
```

```
    static int area[4] = {1, 6, 21, 43};

    int nAreaEnd[4];

    for (int i = 0; i < 4; i++) {
        nAreaEnd[i] = -1;
    }

    int nArea = 1;
    int nCoef = 0;

    for (i = 0; pRuns[i] != EOB; i++) {
        if (pRuns[i] > EOB) // skip invalid entry
            continue;

        nCoef += pRuns[i] + 1;

        if ((nArea < 4) && (nCoef >= area[nArea])) {
            nAreaEnd[nArea-1] = i-1;
            nArea++;
        }
    }

    int nLastEntry = i-1;

    for (i = 0; i < 4; i++) {
        if (nAreaEnd[i] == -1) {
            nAreaEnd[i] = nLastEntry;
        }
    }
```

```
int nTotalReducedSize = 0;
```

```
int nReducedSize;
int nLastAmp;
int nLastRun;
int nLastPos;
```

FIG.21

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for (i = 3; i > 0; i--) {

if (sQStepReducible (nQno, nClassNo, i))

```

    if (nAreaEnd[i] < nLastEntry) {
        nLastPos = nAreaEnd[i]+1;
        nLastRun = pRuns[nLastPos];
        nLastAmp = pAmps[nLastPos];
    }

```

```

    } else {
        nLastPos = nLastEntry;
        nLastRun = EOB;
    }

```

int nPrevAreaEnd = (i>0)?nAreaEnd[i-1]: -1;

/*in present area, entires are replaced one after another beginning with higher-order ones*/

for (int j = nAreaEnd[i]; j > nPrevAreaEnd; j--) {

```

    if (pRuns[j] >= EOB)
        continue;

```

/*when amp is 1 or -1 or 0*/

```

    if ((pAmps[j] <= 1) || (pAmps[j] >= -1)) {
        nReducedSize = sHuffmanReducibleToAmp0(pAmps[j], pRuns[j], nLastAmp, nLastRun);
    }

```

```

    if (nReducedSize >= 0) {

```

```

        if (nLastRun == EOB) {

```

```

            pRuns[j] = EOB; // set the end of data

```

```

        } else {

```

```

            pAmps[j] = nLastAmp;

```

```

            pRuns[j] += nLastRun + 1; // run is add

```

```

            pRuns[nLastPos] = 255; // marking to indicate that entry is invalid

```

```

        }

```

```

    } else {

```

```

        /*amp takes other value*/

```

```

        nReducedSize = sHuffmanReducible(pAmps[j], pRuns[j]);

```

```

        if (nReducedSize > 0)

```

```

            pAmps[j] -= (pAmps[j] > 0) ? 1 : (-1); /*amp is replaced*/

```

```

    }

```

```

    if (nReducedSize > 0) {

```

```

        nTotalReducedSize += nReducedSize;

```

```

        if (nTotalReducedSize >= nReducingSize)

```

```

            return nTotalReducedSize; /*end since target reduction has attained*/

```

```

    }

```

```

    nLastAmp = pAmps[j];

```

```

    nLastRun = pRuns[j];

```

```

    nLastPos = j;

```

```

}

```

```

return nTotalReducedSize;

```

FIG.22

| INPUT CODE WORD | NEW CODE WORD | INPUT(run, amp) →NEW(run, amp) |
|--------------------|------------------|-----------------------------------|
| 1000s | 010s | (0, 3) → (0, 2) |
| 10110s | 1001s | (0, 5) → (0, 4) |
| 110010s | 10111s | (0, 7) → (0, 6) |
| 1101101s | 110011s | (0, 9) → (0, 8) |
| 111111100010111s | 111101111s | (0, 23) → (0, 22) |
| 1101011s | 10101s | (1, 3) → (1, 2) |
| 11100111s | 1101100s | (1, 5) → (1, 4) |
| 1111100100s | 111101010s | (1, 9) → (1, 8) |
| 111110111101s | 11111010101s | (1, 15) → (1, 14) |
| 11100110s | 1101010s | (2, 3) → (2, 2) |
| 111110111000s | 1111100011s | (2, 7) → (2, 6) |
| 111100110s | 11100100s | (3, 3) → (3, 2) |
| 111110110111s | 11111010010s | (3, 7) → (3, 6) |
| 111100111s | 11100101s | (4, 3) → (4, 2) |
| 111110110110s | 11111010001s | (4, 5) → (4, 4) |
| 1111100000s | 111100100s | (5, 3) → (5, 2) |
| 11111010000s | 111100101s | (6, 3) → (6, 2) |

FIG.23

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| | Y ₀ | Y ₁ | Y ₂ | Y ₃ | Cr | Cb |
|-----|-----------------|-----------------|----------------|----------------|-----|-----------------|
| MB0 | B ₀ | B ₀₁ | ... | ... | ... | B ₀₅ |
| MB1 | B ₁₀ | B ₁₁ | | | | |
| MB2 | B ₂₀ | ⋮ | ⋱ | | | |
| MB3 | B ₃₀ | ⋮ | | ⋱ | | |
| MB4 | B ₄₀ | ⋮ | | | | B ₄₅ |

FIG.24

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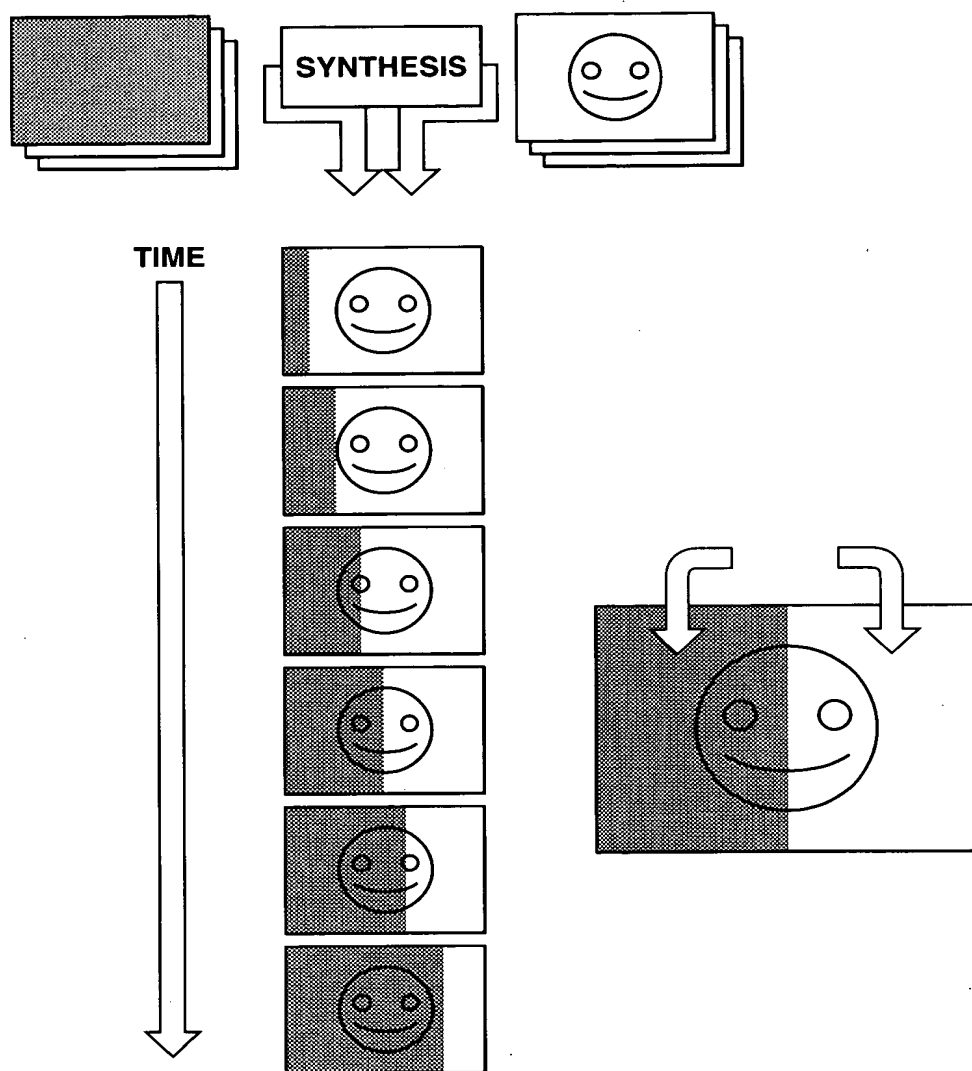


FIG.25

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